Assignment 01

1. Simple Car Controller

Simulate by using simple and scene 3 in program cargui.

- ZhichengSimpleCarControlTest.java
- ZhichengSimpleCarController.java

2. Dubin Car Controller

Simulate by using Dubin and Scene 3 in program CarGUI.

- ZhichengDubinCarControlTest.java
- ZhichengDubinCarController.java

3. Optimal Dubin Car Controller

Simulate by using Dubin and Scene 3 in program CarGUI.

Definition and Simplification

- 1. The dubin car is simplified as a point and its shape is ignored. It means that "hit the obstacle" only happens when its coordinate crosses the boundary of the obstacle.
- 2. To counteract the influence of ignoring the shape, the obstacle is enlarged 10px on each side the boundary is $\{(x,y)|140 \le x \le 260, -10 \le y \le 110\}$.
- 3. The minimum time interval is 0.1 second.
- 4. Define variable w1 and w2 as the left and right speed of the dubin car in each phase, in order to distinguish from variable v1 and v2 (only in phase 2). Program <code>Cargul</code> ONLY accepts the left and right speed in [-10,10].
 - In phase 1, w1, w2 are integers in [-10, 10] and w1 = -w2 (rotate only keep the coordinate of the dubin car unchanged).
 - In phase 2, w1 and w2 are integers in [0, 10], which is the range of v1 and v2.
 - In phase 3, w1, w2 are rationals in [-10, 10] (rotate the dubin car precisely to "facing right") and w1 = -w2.
 - In phase 4 (if exist), w1 = w2 = 10 (top speed).
- 5. The minimum interval of variable A is 0.05 radian, since it is the minimum rotate speed of the dubin car in phase 1. Also, A is no lager than 1.6 radian (91.6732°). To sum up $A=\{\frac{k}{20}|0\leq k\leq 32, k\in\mathbb{Z}\}.$
- 6. The minimum rotate speed of the dubin car in phase 1 is +0.05 radian keep w1=-1 and w2=1 for 1 tick.

- 7. The maximum rotate speed of the dubin car in phase 1 and phase 3 is ± 0.5 radian keep $w1=\mp 10$ and $w2=\pm 10$ for 1 tick. Rotate more means more ticks. Rotation ticks are also included in total time.
- 8. The coordinate of target point is (500,50). Define target area as $\{(x,y)|495 \le x \le 500, 45 \le y \le 55\}$. "hit the target" is simplified as cross the boundary of the target area.

Method

Based on the range of A, v1, v2 below, there are $32 \times 11 \times 11 = 3872$ possible input.

Use library DubinCarSimulator.class to simulate the driving process to simulate each input. During the simulation, the time of each step is set as 0.1 second.

After each step, check out whether the location of the dubin car violate restrictions below. If true, stop simulate and mark the input as invalid.

Keep doing this until all input has been handled. The optimal solution is the valid input with minimun time.

Restriction

- 1. $v1 > v2 \ge 0$ (keep turning right in phase 2)
- 2. The dubin car should NOT hit the obstacle.
- 3. The dubin car should ALWAYS in area $\{(x,y)|50 \le x \le 500, 45 \le y \le 475\}$ (the upper boder is about y=475).

Realization

- ZhichengStep.java
- ZhichengSolution.java
- ZhichengOptimal.java
- ZhichengOptimalDubinCarController.java based on the optimal solution

Result

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Parameters of Optimal Solution:
    A = 0.9rad
    v1 = 10
    v2 = 9

Steps of Optimal Solution: (10600ms)
[{ left: -10.0, right: 10.0, time: 100, globalTime: 100 }
, { left: -8.0, right: 8.0, time: 100, globalTime: 200 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 300 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 400 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 500 }
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, { left: 10.0, right: 9.0, time: 100, globalTime: 600 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 700 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 800 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 900 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 1000 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 1100 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 1200 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 1300 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 1400 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 1500 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 1600 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 1700 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 1800 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 1900 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 2000 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 2100 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 2200 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 2300 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 2400 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 2500 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 2600 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 2700 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 2800 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 2900 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 3000 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 3100 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 3200 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 3300 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 3400 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 3500 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 3600 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 3700 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 3800 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 3900 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 4000 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 4100 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 4200 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 4300 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 4400 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 4500 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 4600 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 4700 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 4800 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 4900 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 5000 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 5100 }
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, { left: 10.0, right: 9.0, time: 100, globalTime: 5400 }
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, { left: 10.0, right: 9.0, time: 100, globalTime: 5700 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 5800 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 5900 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 6000 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 6100 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 6200 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 6300 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 6400 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 6500 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 6600 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 6700 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 6800 }
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, { left: 10.0, right: 9.0, time: 100, globalTime: 7000 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 7100 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 7200 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 7300 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 7400 }
, { left: 10.0, right: 9.0, time: 100, globalTime: 7500 }
, { left: -10.0, right: 10.0, time: 100, globalTime: 7600 }
, { left: -8.50000000000028, right: 8.5000000000028, time: 100, globalTime: 7700
, { left: 10.0, right: 10.0, time: 100, globalTime: 7800 }
, { left: 10.0, right: 10.0, time: 100, globalTime: 7900 }
, { left: 10.0, right: 10.0, time: 100, globalTime: 8000 }
, { left: 10.0, right: 10.0, time: 100, globalTime: 8100 }
, { left: 10.0, right: 10.0, time: 100, globalTime: 8200 }
, { left: 10.0, right: 10.0, time: 100, globalTime: 8300 }
, { left: 10.0, right: 10.0, time: 100, globalTime: 8400 }
, { left: 10.0, right: 10.0, time: 100, globalTime: 8500 }
, { left: 10.0, right: 10.0, time: 100, globalTime: 8600 }
, { left: 10.0, right: 10.0, time: 100, globalTime: 8700 }
, { left: 10.0, right: 10.0, time: 100, globalTime: 8800 }
, { left: 10.0, right: 10.0, time: 100, globalTime: 8900 }
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, { left: 10.0, right: 10.0, time: 100, globalTime: 9300 }
, { left: 10.0, right: 10.0, time: 100, globalTime: 9400 }
, { left: 10.0, right: 10.0, time: 100, globalTime: 9500 }
, { left: 10.0, right: 10.0, time: 100, globalTime: 9600 }
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, { left: 10.0, right: 10.0, time: 100, globalTime: 9900 }
, { left: 10.0, right: 10.0, time: 100, globalTime: 10000 }
, { left: 10.0, right: 10.0, time: 100, globalTime: 10100 }
, { left: 10.0, right: 10.0, time: 100, globalTime: 10200 }
, { left: 10.0, right: 10.0, time: 100, globalTime: 10300 }
, { left: 10.0, right: 10.0, time: 100, globalTime: 10400 }
, { left: 10.0, right: 10.0, time: 100, globalTime: 10500 }
, { left: 10.0, right: 10.0, time: 100, globalTime: 10500 }
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